IS 3710 (1978): Filling Ratios for Low Pressure Liquefiable Gases Contained in Cylinders [MED 16: Gas Cylinders]

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FILLING RATIOS FOR LOW PRESSURE LIQUEFIABLE GASES CONTAINED IN CYLINDERS

(First Revision)

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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Indian Standard

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Indian Standard

FILLING RATIOS FOR LOW PRESSURE LIQUEFIABLE GASES CONTAINED IN CYLINDERS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 27 April 1978, after the draft finalized by the Gas Cylinders Sectional Committee had been approved by the Mechanical Engineering Division Council.

0.2 Manufacture, possession and use of any gas when contained in cylinders in compressed or liquefied state is regulated under the Gas Cylinder Rules, 1940, of the Government of India as amended from time to time. This standard has been prepared in consultation and agreement with the statutory authorities under those rules.

0.3 This standard was first issued in 1966 and covered both low pressure and high pressure liquefiable gases. In this revised version, filling ratios for only low pressure liquefiable gases have been specified, the high pressure liquefiable gases being covered by a separate standard. This change was necessitated because in the case of high pressure liquefiable gases the internal pressure developed by the contents of the gas varies with the filling ratio, as opposed to low pressure liquefiable gases where it is constant (and equals the saturated vapour pressure). Thus in the case of former it is possible to specify numerous filling ratio values each of which is associated with a given developed pressure.

0.4 To ensure safety during handling, transport and use of gas cylinders, it is essential that a correct filling procedure is adopted and gas cylinders or containers are not filled to an excessive weight. With low pressure liquefiable gases, the safe filling of cylinder or containers is largely a matter of ensuring that there is some vapour space left in the cylinder at the maximum attainable temperature, which is taken as 65°C for India. In other words no hydraulic pressure should develop inside.

0.5 Additional information like the liquid density of the gas at 15°C has also been included in this standard for the benefit of fillers and users.

0.6 Nothing in the standard implies that other special requirements, such as purity, dryness, addition of an inhibitor of polymerization, etc, may not be necessary to avoid danger.

0.7 Appropriate precautions shall be taken to ascertain the true water capacity of the cylinder and to ensure correctness in the mass of the gas charged in the cylinder.

0.8 This standard is based on data taken from BS 1736 : 1951 'Specification for filling ratios for liquefiable gases' and BS 5355 : 1976 'Filling ratios and developed pressures for liquefiable and permanent gases' issued by the British Standards Institution. Data from other sources has also been taken in a few cases.

0.9 The quantities in this standard have been expressed in technical metric units. However, in view of the introduction of International System (SI) units in the country, the relevant SI units and the corresponding conversion factors are given below for guidance:

1 kgf/cm^2 = 98·066 5 kPa (kilopascal) = 0·098 066 5 MPa (megapascal) = 0·980 665 bar.

0.10 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960*. The number of significant places retained in the rounded off value should be the same as that of the specified values in this standard.

1. SCOPE

1.1 This standard specifies the filling ratios to be used when low pressure liquefiable gases are filled into transportable gas cylinders.

1.1.1 Filling ratios for high pressure liquefiable gases have been covered in IS : 8866-1978†.

2. TERMINOLOGY

2.1 For the purpose of this standard, the following definitions in addition to those given in IS : 7241-1974‡ shall apply.

2.1.1 *Low Pressure Liquefiable Gas* — A liquefiable gas having a critical temperature above 70°C.

*Rules for rounding off numerical values (*revised*).

†Filling ratios and corresponding developed pressure for high pressure liquefiable gases contained in gas cylinders.

‡Glossary of terms used in gas cylinder technology.

2.1.2 *Filling Ratio* — The ratio of the mass of a liquefiable gas introduced in the cylinder to the mass of the water the cylinder will hold at 15°C.

3. FILLING RATIOS

3.0 General — While filling the cylinder, precaution shall be taken to ensure that the cylinder is free from foreign matter and moisture, and the cylinder is filled in such a manner that the filling ratio is not exceeded.

3.1 Low Pressure Liquefiable Gases Other than Hydrocarbon Gases — For this group of gases, filling ratios are determined on the basis of allowing such a mass of gas to be charged into cylinder that when the temperature rises to 65°C, the liquid portion would occupy approximately 95 percent of the cylinder volume. Thus the filling ratios so defined numerically equal 0·95 times the density of liquefied gas at 65°C, when the density is expressed in grams per millilitre. Where, however, there is limited experience with any particular gas or the accuracy of the determination of the density at the relevant temperature is doubtful, the ratios are calculated on the basis that at 65°C the liquid portion should not occupy more than 90 percent of the cylinder volume. The maximum filling ratios for these gases are given in Table 1 and relate to pure gases.

3.2 Low Pressure Liquefied Hydrocarbon Gases — Among hydrocarbon gases mixtures of two or more gases of varying composition are more common than pure gases. These mixtures may contain several hydrocarbons and their composition may vary from time to time. The filling ratio to be used is generally obtained from the density at the maximum attainable temperature of 65°C. Since it is not convenient to carry out the routine determination of the density at 65°C, in practice density determination is made at some lower temperature. Table 2 gives the filling ratios for 65°C when density determination is done at temperature other than 65°C. The conversion table given is applicable to saturated hydrocarbon mixtures as also to hydrocarbon mixtures containing a maximum of 10 percent of unsaturated hydrocarbons. For gas mixtures containing more than 10 percent of unsaturated hydrocarbons, it is recommended that the filling ratios are calculated from the actual density determination at 65°C.

3.3 Miscellaneous Gases — For those gases and gas mixtures which are not covered in Table 1 or 2, the filling ratios shall be determined so as to allow 5 percent free vapour space in the cylinder at 65°C. However, if there is any doubt as to the accuracy of the density determination, a free space of 10 percent shall be allowed for the vapour.

TABLE 1 FILLING RATIOS FOR LOW PRESSURE LIQUEFIABLE GASES OTHER THAN HYDROCARBON GASES

(*Clause* 3.1)

NAME OF GAS	FILLING RATIO	LIQUID DENSITY AT 15°C
(1)	(2)	(3)
		g/ml
Ammonia	0·51	0·617
Boron trichloride	1·17	1·344
Butadiene (vinylethylene, divinyl)	0·50	0·626
Butane (normal)	0·50	0·584
Butene	0·53	—
Chlorine	1·19	1·424
Chlorine trifluoride	1·59	1·840
Cyanogen	0·72	—
Cyanogen chloride	0·96	1·179
Cyclopropane	0·48	0·615
Dichlorodifluoromethane (R-12*)	1·08	1·346
Dichloromonofluoromethane (R-21*)	1·20	1·390
1,2 Dichlorotetrafluoroethane (R-114*)	1·26	1·486
1,1 Difluoroethane (ethylidene fluoride) (R-152a*)	0·74	0 924
Dimethylamine	0·52	0·661
Dimethylether (methyl ether, methyl oxide)	0·56	0·676
Ethylamine (aminoethane)	0·60	0·688
Ethyl chloride (chloro-ethane)	0·79	0·900
Ethylene oxide	0·76	0·876
Hydrogen bromide (anhydrous)	1·20	—
Hydrogen cyanide (anhydrous)	0·57	0·694
Hydrogen fluoride (anhydrous)	0·80	0·978
Hydrogen sulphide	0·63	0·800
Isobutane (2-methyl propane) (R-600a*)	0·47	0·566
Isobutylene	0·53	—
Methylamine (aminomethane)	0·54	0·666

*This is the refrigerant number of the gas in accordance with ISO/R 817-1974 ' Organic Refrigerants — Number Designation ' issued by the International Organization for Standardization.

(*Continued*)

TABLE 1 FILLING RATIOS FOR LOW PRESSURE LIQUEFIABLE GASES OTHER THAN HYDROCARBON GASES — *Contd*

Name of Gas	Filling Ratio	Liquid Density at 15°C
(1)	(2)	(3)
		g/ml
Methyl bromide	1·39	1·690
Methyl chloride	0·78	0·927
Methylmercaptan (methanethiol)	0·78	—
Monochlorodifluoroethane (R-142b*)	0·95	1·133
Monochlorodifluoromethane (R-22*)	0·90	1·231
Monochloromonobromodifluoromethane (R-12B_1*)	1·56	1·833
Monochloropentafluoroethane (R-115*)	1·00	1·334
Monochlorotetrafluoroethane (R-124a*)	1·15	—
Monochlorotrifluoroethane (R-133a*)	1·14	1·352
Monochlorotrifluoroethylene (R-1113*)	1·00	—
Nitrogen tetroxide (Nitrogen peroxide)	1·20	1·458
Nitrosyl chloride	1·04	1·312
Octafluorocyclobutane (R-C318*)	1·25	1·539
Phosgene (carbonyl chloride)	1·19	1·385
Propane	0·40	0·509
Propene	0·40	0·524
Refrigerant gas mixture R-500* (R-12* 73·8% + R-152a* 26·2%, by mass)	0·94	1·189
Refrigerant gas mixture R-502* (R-22* 48·8% + R-115* 51·2%, by mass)	0·97	1·285
Refrigerant gas mixture (R-12* 88% + ethylene oxide 12%, by mass)	1·05	1·294
Sulphur dioxide	1·19	1·395
Trichloromonofluoromethane (R-11*)	1·30	—
Trimethylamine	0·51	0·639
Vinyl bromide	1·25	—
Vinyl chloride	0·78	0·920
Vinyl methyl ether (methyl vinyl oxide)	0·60	—

*This is the refrigerant number of the gas in accordance with ISO/R 817-1974 ' Organic Refrigerants — Number Designation ' issued by the International Organization for Standardization.

TABLE 2 FILLING RATIOS FOR LIQUEFIED HYDROCARBON GASES ASSUMED MAXIMUM TEMPERATURE 65°C

(*Clause* 3.2)

Density, g/ml \ Temperature for Density Determination	0°C	5°C	10°C	15°C	20°C	25°C	30°C
	Filling Ratios						
0·500	0·358	0·368	0·378	0·388	0·400	0·409	0·418
0·505	0·364	0·375	0·384	0·396	0·406	0·415	0·423
0·510	0·371	0·382	0·392	0·402	0·413	0·421	0·430
0·515	0·378	0·389	0·400	0·409	0·418	0·427	0·436
0·520	0·385	0·396	0·406	0·415	0·424	0·433	0·442
0·525	0·393	0·403	0·413	0·421	0·431	0·440	0·448
0·530	0·401	0·411	0·419	0·428	0·437	0·446	0·454
0·535	0·408	0·417	0·426	0·435	0·444	0·452	0·460
0·540	0·415	0·422	0·435	0·442	0·450	0·458	0·466
0·545	0·421	0·430	0·440	0·448	0·456	0·465	0·471
0·550	0·429	0·437	0·447	0·454	0·463	0·470	0·477
0·555	0·436	0·447	0·452	0·462	0·468	0·475	0·484
0·560	0·444	0·451	0·460	0·467	0·474	0·482	0·489
0·565	0·449	0·458	0·466	0·475	0·481	0·488	0·494
0·570	0·456	0·465	0·471	0·480	0·487	0·493	0·500
0·575	0·464	0·470	0·478	0·486	0·492	0·500	0·506
0·580	0·470	0·477	0·485	0·491	0·500	0·506	0·513
0·585	0·476	0·483	0·490	0·498	0·504	0·512	0·519
0·590	0·484	0·490	0·497	0·504	0·512	0·518	0·525
0·595	0·490	0·496	0·504	0·511	0·519	0·525	0·531
0·600	0·495	0·503	0·511	0·518	0·525	0·531	0·537
0·605	0·501	0·508	0·514	0·520	—	—	—
0·610	0·507	0·514	0·520	0·525	—	—	—
0·615	0·514	0·520	0·525	—	—	—	—
0·620	0·520	0·525	—	—	—	—	—
0·625	0·525	—	—	—	—	—	—

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BUREAU OF INDIAN STANDARDS

Headquarters :

Manak Bhavan, 9 Bahadur Shah Zafar Marg, NEW DELHI 110002

Telephones : 331 01 31
331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

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